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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

LEA 32 509

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/601571

INTERNATIONAL APPLICATION NO.

PCT/EP99/00411

INTERNATIONAL FILING DATE

22 January 1999 (22.01.99)

PRIORITY DATE CLAIMED

04 February 1998 (4.02.98)

TITLE OF INVENTION

ELECTROCHROMIC DISPLAY

APPLICANT(S) FOR DO/EO/US

BERNETH, Horst; CLAUSSEN, Uwe and JACOBSEN, Wolfgang

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND or SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
 - 1) Certification of Mailing under 37 C.F.R. 1.10;
 - 2) Transmittal of Information Disclosure Statement;
 - 3) Information Disclosure Citation (Modified Form PTO-1449);
 - 4) References cited; and
 - 5) Return Receipt Post Card.

Date of Deposit: 3 August 2000

APPLICATION NO. 09/601571

INTERNATIONAL APPLICATION NO.
PCT/EP99/00411ATTORNEY'S DOCKET NUMBER
LEA 32 509

17. <input type="checkbox"/> The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$970.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$840.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$760.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$670.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$96.00 ENTER APPROPRIATE BASIC FEE AMOUNT =					
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(c)).					
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	13 -20 =	0	X \$18.00	\$ 00.00	
Independent claims	1 -3 =	0	X \$78.00	\$ 00.00	
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+\$260.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 840.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$ 840.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 840.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 840.00	
				Amount to be: refunded	\$
				charged	\$

- a. ☐ A check in the amount of \$_____ to cover the above fees is enclosed.
- b. ☒ Please charge my Deposit Account No. 13-3372 in the amount of \$ 840.00 to cover the above fees.
A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
overpayment to Deposit Account No. 13-3372. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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41.670

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS: Berneth, *et al.*
SERIAL NO.: National Stage Filing of PCT/EP99/00411
FILING DATE: Herewith
TITLE: Electrochromic Display

PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This Preliminary Amendment is submitted in the above-captioned national stage application of PCT/EP99/00411 filed on even date herewith. Please amend the application as follows:

In the Claims

Please amend claims 5, 7, and 9 – 13 as follows:

5. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 4], characterized in that both electrode sheets have a periodic or aperiodic pattern of strips or grids made of a material having metallic conductivity.
7. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 6], characterized in that the pattern of strips or grid made of the material having electrical conductivity is aperiodic on at least one electrode.
9. (Amended) Electrochromic display element according to Claim 7 [or 8], characterized in that the arrangement of the aperiodic grid is such that the mean of the distance between two neighboring points of intersection of the

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grid, taken over all points of intersection of the grid, corresponds to the dot spacing of a periodic dot grid having the same size and the same number of grid points and in that the autocorrelation function of the grid decreases rapidly in all directions for values which are greater than a.

10. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 9], characterized in that the metal grid or pattern of strips on the electrode or electrodes is deposited on the transparent, electrically conductive layer.
11. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 10], characterized in that the transparent, electrically conductive layer on the electrode is deposited on the metal grid or pattern of strips.
12. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 11], characterized in that the grid or pattern of strips of at least one electrode has a minimum mesh spacing of 3 mm.
13. (Amended) Electrochromic display element according to [one or more of] Claim[s] 1 [to 12], characterized in that the grid or pattern of strips has a maximum optical density of 0.3.

Remarks

By way of this Preliminary Amendment, claims 1-13 are pending. Claims 5,7 and 9-13 have been amended. These claim amendments and additions are being made solely for purposes of eliminating multiple claim dependencies.

Applicants believe that the subject matter of the pending claims is patentable and that the instant application should accordingly be allowed. If the Examiner believes that a conversation with Applicants' attorney would be helpful in expediting

prosecution of this application, the Examiner is invited to call the undersigned attorney at (203) 812-3964.

Dated: August 3, 2000

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001060 T2E10360

Electrochromic display

5 The present invention relates to electrooptical displays, particularly those having large switchable areas in the form of electrically switchable mirrors, windows or display elements.

10 In principle, electrooptical displays are constructed of two parallel capacitor plates which together with a sealing frame located between them define a flat chamber in which there is a medium which changes its optical anisotropy, its absorption behaviour and/or its colour under the action of a voltage applied to the capacitor plates. At least one of the capacitor plates comprises a light-transparent material, for example glass or plastic (e.g. polycarbonate) which is provided on the side which is in contact with the electrochromic medium with an electrically conductive, light-transparent layer, in particular indium-tin oxide (ITO).

15 Such displays are known in principle from US-A 3 451 741, EP-A 240 226 and WO 94/23 333.

20 In the case of large electrooptical switching areas in which the electrooptical medium additionally has a certain conductivity, particularly in the case of electrochromically switchable areas, irregularities in the coloration of the area occur. On the one hand, it is then often not possible to produce large areas having a uniform intensity of colour. On the other hand, on switching, the coloration spreads like a wave across the area. Such wave-like colour intensity fluctuations sometimes display the character of vibrations which occur even independently of the switching process if the power, as
25 is customary, is supplied via the edge of the switching area.

30 These irregularities in the coloration have been able to be attributed to the comparatively high specific resistance of the transparent, conductive layers which is typically from 1 to 200 ohm per square.

35 It is known from FR 2 689 655, EP 618 477 and EP 294 756 that metal strips or metal grids can be applied to the counterelectrode of electrochromic cells based on electrochromic films. In the case of electrochromic cells based on liquid electrochromic media and having two equivalent electrodes, such a structuring of one or both electrodes has not previously been proposed since it was not clear a priori whether preferred current paths through the liquid medium would be formed so that,

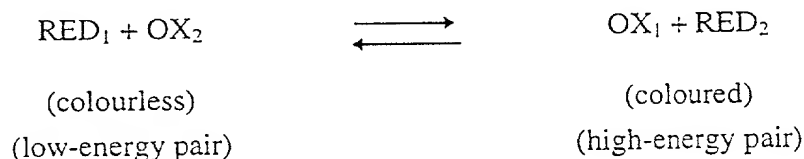
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on application of a voltage, a more distinct coloration would occur in the region of the grid than between the grid lines.

5 The display cell of the invention contains an electrochromic medium which can be a liquid, a gel or a solid. Preference is given to liquids and gels. They contain one or more electrochromic substances, a solvent, one or more UV absorbers, if desired one or more conductance salts and, if desired, one or more thickeners.

10 Electrochromic substances which are suitable for the purposes of the invention are pairs of redox substances of which one is reducible and the other is oxidizable. Both are colourless or only slightly coloured. On application of a voltage to the display, one substance is reduced and the other is oxidized, with at least one becoming coloured. After switching off the voltage, the two original redox substances are formed again and the display decolorizes.

15



20 It is known from US patent 4,902,108 that suitable pairs of redox substances are those in which the reducible substance has at least two chemically reversible reduction waves in the cyclic voltammogram and the oxidizable substance correspondingly has at least two chemically reversible oxidation waves. Such substances are suitable for the purposes of the invention.

25 WO 97/30134 discloses redox systems in which RED_1 and OX_2 or OX_1 and RED_2 are covalently bound via a bridge B. Such substances are likewise suitable for the purposes of the invention.

30 Likewise suitable for the purposes of the invention are redox systems in which the reversible transition between RED and OX or vice versa is associated with the breaking or the formation of a σ bond. Such substances are known, for example, from WO 97/30135.

Also suitable for the purposes of the invention are metal salts or metal complexes of those metals which exist in at least two oxidation states. The two oxidation states advantageously differ by 1.

Likewise suitable for the purposes of the invention are oligomers and polymers which contain at least one of the redox systems mentioned or else pairs of such redox systems as are defined above.

5

Likewise suitable for the purposes of the invention are mixtures of the above-described substances, provided that these mixtures contain at least one reducible and at least one oxidizable redox system.

10 Suitable solvents, conductance salts, UV absorbers and thickeners are likewise known from the above-cited patent applications and can be utilized for the purposes of the invention.

15 According to the invention, it is now proposed that a pattern of strips or a grid made of a material having metallic conductivity be located above or below the transparent, electrically conductive layer of the display cell of the invention.

The pattern of strips or grid serves to even out local resistance fluctuations in the transparent, electrically conductive layer and to avoid voltage decreases in the layer.
20 Surprisingly, this does not result in the formation of preferred current paths, but instead a uniform and rapid, uniform coloration of the switching area is produced.

The present invention accordingly provides an electrochromic display element which contains an electrochromic liquid between two electrode sheets, where at least one of
25 the electrode sheets is transparent and has a transparent, electrically conductive layer, characterized in that the transparent electrode sheet or sheets has/have a pattern of strips or grid made of a material having metallic conductivity. Preferably less than 10%, particularly preferably less than 3%, of the display switching area is covered by the pattern of strips or grid having metallic conductivity.

30

The width of the strips and their spacing is advantageously determined as a function of the distance from which the display is viewed, as derived from the intended purpose of the display. The width of the metallic strips is advantageously selected such that the strips are not perceived by the viewer. If the display is configured as an
35 electrically dimmable rear view mirror for motor vehicles, the strips preferably have a width of from 10 to 50 μm . Wider strips can be accepted if the display is

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configured as, for example, a display board in airports or the like where the viewing distance is large.

- 5 In the case of such large-area displays, it is also possible to employ regular grids in which the line spacing is greater than 3 mm.

Typically, the ratio of the width of the strips to the distance between the strips can be from 1/10 to 1/10,000, preferably from 1/10 to 1/1000, particularly preferably from 1/10 to 1/100.

10

The metal grid can be applied in various ways. It can be applied to the substrate by sputtering, vapour deposition including chemical vapour deposition (CVD) or by adhesive bonding of a finished grid. The metal itself should have a sufficient conductivity which should be greater than $10^4/\text{ohm}$.

15

This grid is coated with a layer of a metal oxide, with preference being given to transparent materials having good conductivity, e.g. In_2O_3 or SnO_2 or ITO or ZnO . These metal oxides can also be doped with traces of fluorides, antimony or aluminium to improve the conductivity.

20

- 25 The substrate has the function of supporting the conductive layer. In addition, it has to be transparent and serve as a barrier against chemical reactants of the electrochromic medium, in particular oxygen and water. Suitable substrates are glass or plastics, including in flexible form. The plastics in particular can be coated with layers which greatly reduce the permeation of the materials in question. This coating can be ITO of sufficient thickness or else comprise layers of non-conducting dielectrics such as TiO_2 .

- 30 As an inexpensive alternative to coating the grid with a metallic oxide, it is also possible to use the reverse procedure, namely applying the metallic grid to a metallic oxide on at least one of the electrodes. This has the advantage that it is possible, in this case, to employ cheap substrates, e.g. glass/ITO or PET/ITO, without adversely affecting the homogeneity of the coloration.

- 35 If the metallic oxide layer is structured, i.e. made up of electrically separate parts, the contact grid naturally has to be structured in an analogous way.

Preferably, both electrode sheets are provided with a pattern of strips or grid of electrically conductive material. In this case, the pattern of strips on the two electrode sheets can also be arranged at right angles to one another. The grids on the two electrode sheets can also be arranged such that the grid lines of one grid run diagonal to the grid lines of the other grid. This configuration of the device of the invention makes it possible to achieve the favourable effect of rapid and uniform coloration of the switching area even in the case of display elements having two transparent electrode sheets which are operated in transmission.

10 A further significant improvement in the device of the invention is achieved by using a contact grid having a periodicity restricted to very short distances. The production of an aperiodic grid is in no way trivial. The arrangement according to the invention of the aperiodic contact grid can be described by a physical model. The starting configuration is a regular grid of dots having a dot spacing of a . Each dot in the grid is assigned a dot mass which is connected to each of its 4 nearest neighbours by means of a tensile spring. These springs are pretensioned to a certain degree, i.e. the rest length of the springs is less than the mean spacing between the dots of the grid.

20 The spring constants of the springs are assigned predetermined values randomly distributed about a mean. The energy minimum of the total system is then determined. The resulting positions of the dot masses form a grid having the sought-after properties:

25 The mean distance between two adjacent dots continues to be a . The grid is aperiodic. There is no preferred direction and the autocorrelation function decreases rapidly for values greater than a . The steepness of this decrease can be controlled by the scatter in the values of the spring constants. This means that the arrangement of the contact grid is determined taking the following criteria into account:

- 30 a) The shortest conductor strip connecting any 2 dots of the contact grid should have a mean length which is as short as possible in order to permit no large inhomogeneities in the conductivity of the surface.
- b) The autocorrelation function of the contact grid has to drop very rapidly in all directions.
- 35

- In order to be able to calculate the autocorrelation function of the grid, a function first has to be assigned to this grid. This can be done, for example, by assigning all points (x,y) lying on the lines of the contact grid the value 1 and all other points the value 0. For this function f(x,y), the autocorrelation function can then be determined in a known manner (see, for example, E. Oran Brigham, FFT/Schnelle Fourier-Transformation, R. Oldenbourg Verlag, Munich/Vienna 1982, p. 84 ff.):

$$Z(x,y) = \frac{\int_{-\infty-\infty}^{\infty \infty} f(x^*, y^*) \cdot f(x^*+x, y^*+y) dx^* dy^*}{\int_{-\infty}^{+\infty} (f(x^*, y^*))^2 dx^* dy^*}$$

- 10 In the case of a strictly periodic grid, e.g. a square grid having an edge length of a, the function Z(x,y) has maxima of the same amplitude at all points where $x = n \cdot a$ or where $y = n \cdot a$ (n is an integer) independently of the value of n. As soon as this grid is deformed in such a way that the short-range order is maintained but the long-range order is not, the height of the maxima decreases rapidly with increasing n.
- 15 The arrangement of the contact grid optimized in this way according to the invention has the advantage that it is visually considerably less conspicuous than a periodic grid. As a result, the mean spacing of the grid lines can be made significantly greater and the production costs can be substantially reduced in this way. In particular, the
- 20 greater mean spacing of the grid lines increases the light transmittance of the contact grid. When both electrodes are provided with an aperiodic contact grid according to the invention, the moire effect is suppressed. The moire effect appears as an interference phenomenon when two electrodes lying opposite one another have periodic structures. The moire effect causes, corresponding to the interference
- 25 pattern, an inhomogeneous field distribution between the electrodes and correspondingly an inhomogeneous coloration in the electrochromic cell.

Three basic types of the electrochromic display of the invention can be distinguished:

- 30 Type 1: Full-area electrochromic display, for example for window panes.
- Type 2: Electrically dimmable mirrored display, for example automobile mirrors.

Type 3: Electrochromic image display, for example segmented or matrix displays.

5 In the case of Type 1, use is made of glass or plastic plates which have all of one side coated with a transparent conductive layer. At least one of these layers is a layer according to the invention containing a metallic pattern of strips or grid. This gives a transmissive electrochromic device which can be viewed in transmitted light.

10 In the case of Type 2, plates as in Type 1 are used. In addition, one of the two plates is mirrored. This mirroring can be applied to the second side, which is not coated with conductive material, of one of the two plates. However, it can also be applied instead of the conductive coating mentioned to one of the two plates and thus simultaneously perform the function of conductive layer and mirroring. In this case, this second plate itself can be non-transparent, e.g. an opaque plastic, a metal plate or
15 the like. For the mirroring, it is possible to use silver, chromium, aluminium, palladium or rhodium or other known conductive and reflective mixtures of these materials. This gives a reflective electrochromic device.

20 For Type 3, it is possible to select the construction form of Type 1 or Type 2, thus giving a transmissive or reflective electrochromic display. However, in either case, at least one of the two conductive layers or both is/are divided into electrically separate segments which are individually provided with contacts. It is also possible for only one of the two plates to have a conductive coating and be divided into segments. The segments can be separated, for example, by mechanical removal of the conductive
25 layer, for example by scoring, scratching, scraping or milling or by chemical means, for example by etching by means of, for example, a hydrochloric acid solution of FeCl_2 and SnCl_2 . This removal of the conductive layer can be controlled in terms of position by means of masks, e.g. masks of photoresist. Alternatively, the electrically separate segments can be produced by targeted, e.g. by means of masks, application,
30 e.g. by sputtering or printing, of the conductive layer. The provision of the segments with contacts is carried out, for example, by means of fine strips of conductive material, each of which connects the segment electrically to a contact at the edge of the electrochromic device. These fine contact strips can either consist of the same material as the conductive layer itself and be produced, for example, when the layer
35 is divided into segments as described above, or they can, for example to improve the conductivity, consist of another material such as fine metallic conductors, for example of copper or silver. A combination of metallic material and the material of

the conductive coating is also possible. These metallic conductors can, for example, either be applied in fine wire form, e.g. adhesively bonded on, or be printed on. All these above-described techniques are generally known from the production of liquid crystal displays (LCDs).

5

In the case of the conductive coating according to the invention, it has to be ensured that in each of these segments and their electrical leads there is at least one continuous line of the material having metallic conductivity. This can be achieved, for example, by the mesh spacing of the pattern of strips or grid being smaller than the dimensions of the segments or leads. However, it can also be achieved by, for example, applying lines of the material having metallic conductivity to the glass or plastic plate, for example by sputtering, printing or etching from a continuous coating, which lines run completely through each of the planned segments and their leads. Here, at least one continuous line per segment and its lead can be sufficient. Subsequently, a conductive metal oxide layer can be applied, e.g. by sputtering, printing or coating, to the plates which have been prepared in this way. This metal oxide layer can be applied over the entire area. The segments and their leads then have to be separated from one another in the described manner, e.g. by etching. However, the metal oxide layer can also be applied directly in the form of the segments and their leads, e.g. by sputtering or printing with the aid of masks.

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The displays can be viewed in transmitted light or reflectively by means of mirroring or transflectively by a mixture of these two effects.

Specific embodiments of the abovementioned Types 1 to 3 can, for example, be the following, which are likewise subject matter of the invention:

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30

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Type 1: from the application area of light protection/light filters: window panes for, for example, buildings, road vehicles, aircraft, rail vehicles, ships, skylights, sunroofs in automobiles, glazing of greenhouses and winter gardens, light filters of any type.

from the application area of security/privacy: separation panes for, for example, room partitions in, for example, offices, road vehicles, aircraft, rail vehicles, non-see-through panes on, for example, bank counters, door glazing, visors for, for example, motorcycle or pilot's helmets.

from the application area of design: glazing of cooking ovens, microwave appliances, other household appliances, furniture.

5 Type 2: mirrors of any type, e.g. rear-view mirrors for, for example, road vehicles, rail vehicles, in particular planar, spherical, aspherical mirrors and combinations thereof, e.g. spherical/aspherical, mirror glazing in furniture.

10 Type 3: display devices of any type, e.g. segmented or matrix displays, e.g. for clocks and watches, computers, electric appliances, electronic appliances such as radios, amplifiers, televisions, CD players, etc., destination displays in buses and trains, departure displays in railway stations and airports, flat VDUs, all applications which are mentioned under Type 1 and 2 which contain at least one switchable, static or variable display device, e.g. separation panes which
15 include displays such as "Please do not disturb", "Till not open", e.g. automobile mirrors which include information displays of any type, e.g. indications of temperature, faults in a vehicle (e.g. oil temperature, open doors), time, compass bearing, etc.

The invention is illustrated below with the aid of Figure 1 (attached):

20 Fig. 1 shows an exploded view of the in-principle structure of a display according to the invention in the form of an electrically switchable mirror. The mirror comprises a first glass plate 1 with metallic mirroring 2 and also a second glass plate 7 on which there is applied an aperiodic grid 6. The ITO layer 5 is applied on top of the aperiodic
25 grid 6. Between the coated plates 1 and 7 there is a frame 3 which ensures the spacing of the plates and seals the chamber 4 for the electrochromic liquid. The electrochromic liquid can be introduced under reduced pressure via the orifices 8. A first voltage supply 10 is connected to the electrode layers 2 and 5, 6 via leads 9. Application of a voltage to the voltage supply 10 changes the reflection behaviour of
30 the mirror. In the case of a motor vehicle mirror, the metallic grid 6 can additionally be used for heating. For this purpose, a second voltage source 12 which is connected to the grid 6 via leads 11 is provided.

35 Fig. 2 shows a large-area segmented display element according to the invention for back-lighting, which is suitable, for example, for airport information boards. Like numerals indicate like elements as in Fig. 1.

5

Figure 1 consists of 12 bar charts, each representing a different variable. The x-axis for each chart lists four categories: All respondents, Nonusers, Users, and Former users. The y-axis represents the percentage of respondents, ranging from 0% to 100% in increments of 10%. The variables are as follows:

- Age:** 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+.
- Sex:** Male, Female.
- Education:** High school or less, Some college, Bachelor's degree, Graduate degree.
- Income:** Less than \$10,000, \$10,000-\$19,999, \$20,000-\$29,999, \$30,000-\$39,999, \$40,000-\$49,999, \$50,000-\$59,999, \$60,000-\$69,999, \$70,000-\$79,999, \$80,000-\$89,999, \$90,000-\$99,999, \$100,000+.
- Marital status:** Single, Married, Divorced, Widowed.
- Employment status:** Full-time, Part-time, Unemployed, Retired.
- Religion:** Protestant, Catholic, Jewish, Muslim, Other.
- Political affiliation:** Republican, Democrat, Independent.
- Party affiliation:** Republican, Democrat, Independent.
- Attitude toward unions:** Strongly support, Support, Neutral, Oppose, Strongly oppose.
- Attitude toward unions' role in the economy:** Strongly support, Support, Neutral, Oppose, Strongly oppose.
- Attitude toward unions' role in society:** Strongly support, Support, Neutral, Oppose, Strongly oppose.

Claims

1. Electrochromic display element containing an electrochromic medium between two electrode sheets, where at least one of the electrode sheets is transparent and has a transparent, electrically conductive layer, characterized in that the transparent electrode sheet or sheets has/have a periodic or aperiodic pattern of strips or grid made of a material having metallic conductivity.
2. Electrochromic display element according to Claim 1, characterized in that the electrochromic medium is a solution, a gel or a solid.
3. Electrochromic display element according to Claim 1 and 2, characterized in that the electrochromic medium contains at least one pair of redox substances of which one is reducible and the other is oxidizable, where both are colourless or only slightly coloured and one substance is reduced and the other is oxidized on application of a voltage to the display element, with at least one becoming coloured, and after switching off the voltage the two original redox substances are formed again and the display element decolorizes.
4. Electrochromic display element according to Claim 3, characterized in that
- a) the reducible substance has at least two chemically reversible reduction waves in the cyclic voltammogram and the oxidizable substance correspondingly has at least two chemically reversible oxidation waves, or
 - b) the reducible substance and the oxidizable substance are covalently bound via a bridge B, or
 - c) the reducible and/or oxidizable substances selected are ones in which the reversible transition between the oxidizable form and the reducible form or vice versa is associated with the breaking or the formation of a σ bond, or

- d) the reducible substance and the oxidizable substance are metal salts or metal complexes of metals which exist in at least two oxidation states, or
- 5 e) the reducible and/or oxidizable substances are oligomers and polymers which contain at least one of the redox systems mentioned or else pairs of such redox systems as are defined under a) to d), or
- 10 f) the reducible and/or oxidizable substances used are mixtures of the substances described in a) to e), provided that these mixtures contain at least one reducible and at least one oxidizable redox system.
5. Electrochromic display element according to one or more of Claims 1 to 4, characterized in that both electrode sheets have a periodic or aperiodic pattern of strips or grids made of a material having metallic conductivity.
- 15 6. Electrochromic display element according to Claim 5, characterized in that the lines of the pattern of strips of the two electrodes form an angle with one another.
- 20 7. Electrochromic display element according to one or more of Claims 1 to 6, characterized in that the pattern of strips or grid made of the material having electrical conductivity is aperiodic on at least one electrode.
- 25 8. Electrochromic display element according to Claim 7, characterized in that the periodicity of the pattern of strips or grid on at least one electrode is restricted to a very short distance.
- 30 9. Electrochromic display element according to Claim 7 or 8, characterized in that the arrangement of the aperiodic grid is such that the mean of the distance between two neighbouring points of intersection of the grid, taken over all points of intersection of the grid, corresponds to the dot spacing a of a periodic dot grid having the same size and the same number of grid points and in that the autocorrelation function of the grid decreases rapidly in all directions for values which are greater than a .
- 35

10. Electrochromic display element according to one or more of Claims 1 to 9,
characterized in that the metal grid or pattern of strips on the electrode or
electrodes is deposited on the transparent, electrically conductive layer.
11. Electrochromic display element according to one or more of Claims 1 to 10,
characterized in that the transparent, electrically conductive layer on the
electrode or electrodes is deposited on the metal grid or pattern of strips.
12. Electrochromic display element according to one or more of Claims 1 to 11,
characterized in that the grid or pattern of strips of at least one electrode has a
minimum mesh spacing of 3 mm.
13. Electrochromic display element according to one or more of Claims 1 to 12,
characterized in that the grid or pattern of strips has a maximum optical
density of 0.3.

Electrochromic display

Abstract

The invention describes an electrochromic display element in the form of an electrically dimmable mirror, an optical filter having an electrically alterable transparency or a display element which contains an electrochromic liquid between two electrode sheets, where at least one of the electrode sheets is transparent and has a transparent, electrically conductive layer and the transparent electrode sheet has a pattern of strips or grid made of a material having metallic conductivity in order to produce a uniform coloration of the electrochromic liquid.

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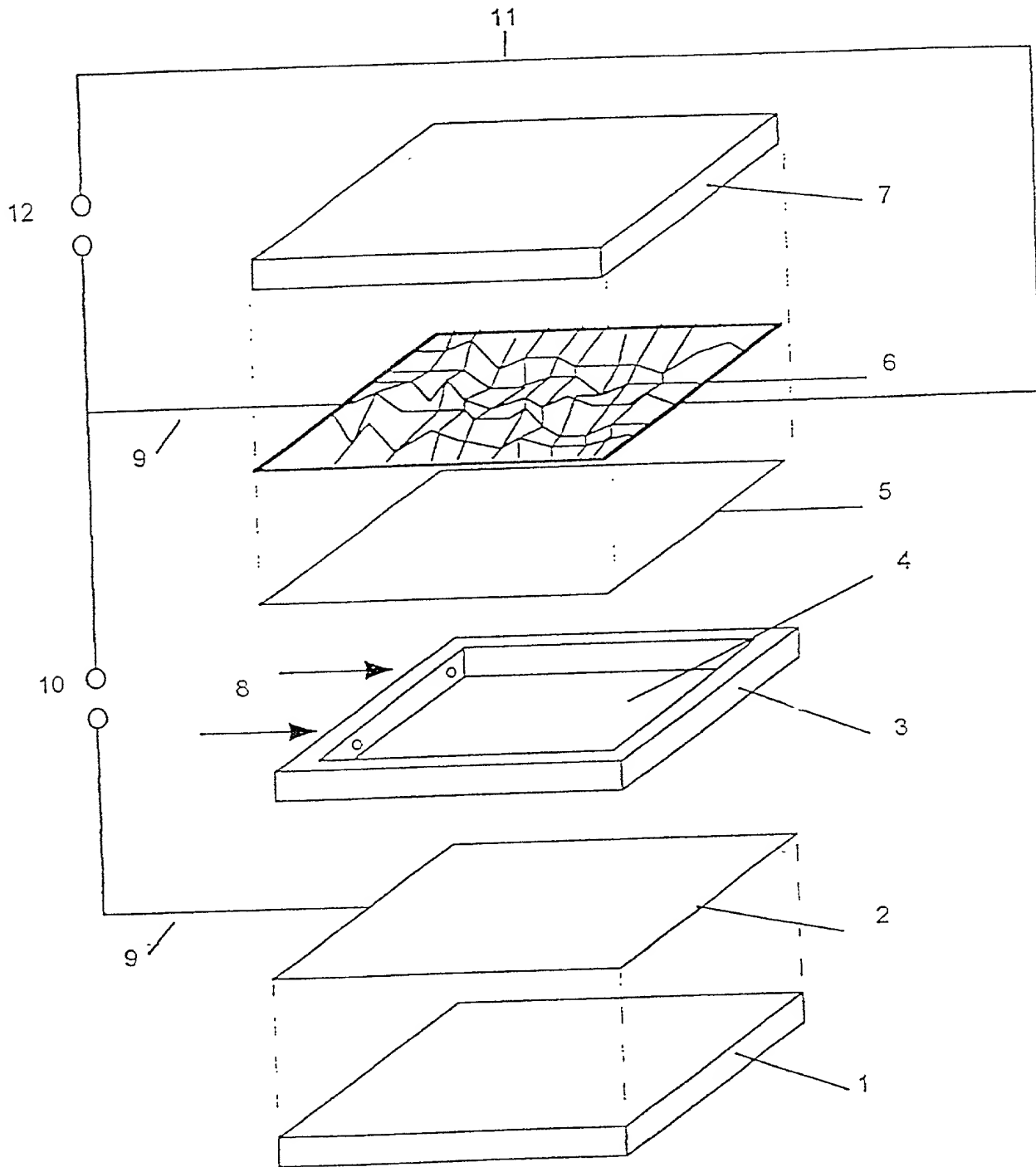


Fig. 1

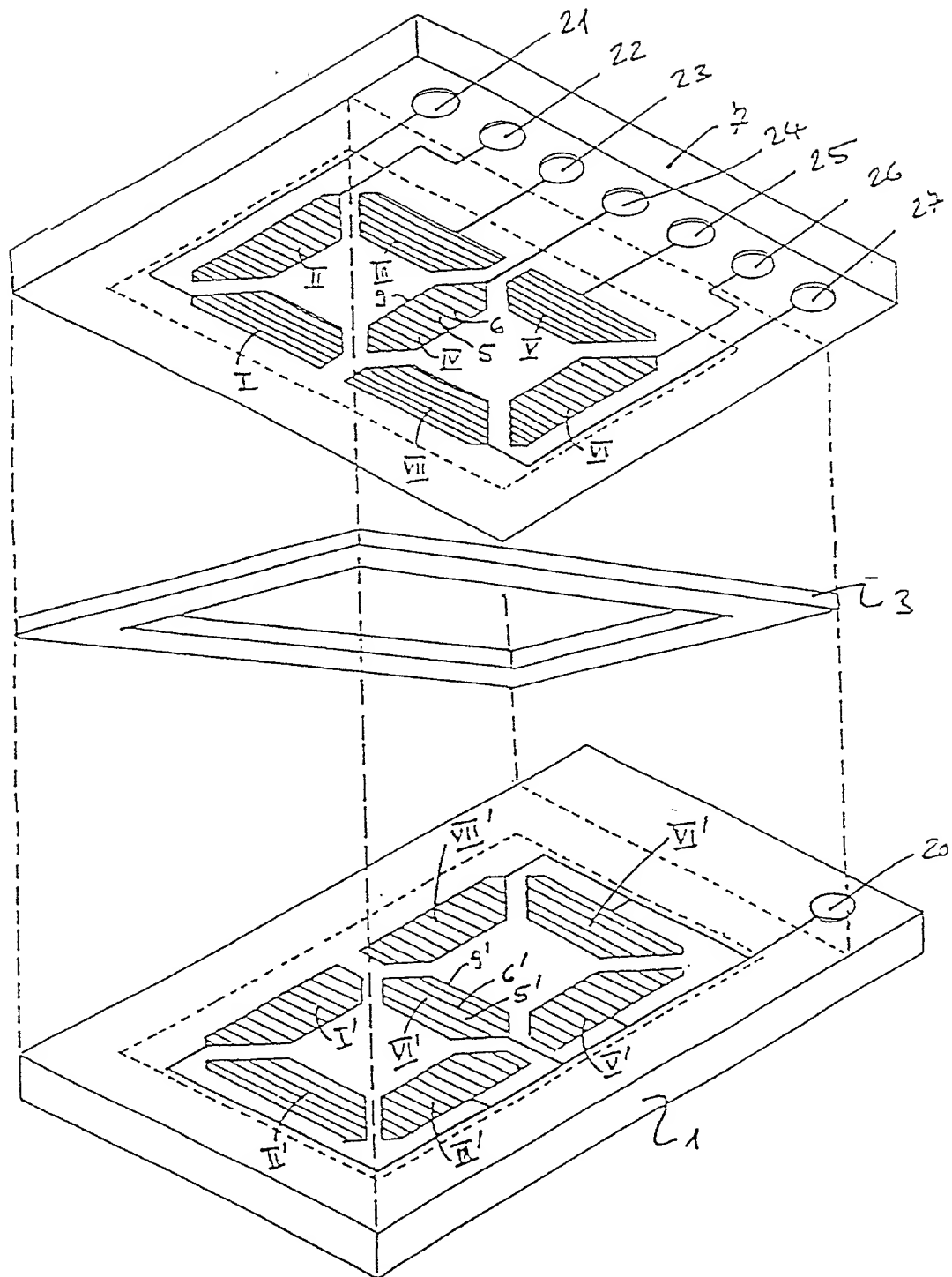


Fig. 2

COMBINED DECLARATION AND POWER OF ATTORNEY

ATTORNEY DOCKET NO

Le A 32 509

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought

on the invention entitled

ELECTROCHROMIC DISPLAY

the specification of which is attached hereto,

or was filed on **January 22, 1999**

as a PCT Application Serial No. **PCT/EP99/00411**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s), the priority(ies) of which is/are to be claimed:

198 04 314.7
(Number)

Germany
(Country)

February 4, 1998
(Month/Day/Year Filed)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose the material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)

(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)

(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Le A 32 509-US

001060 T45T0960

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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	RESIDENCE	CITIZENSHIP	
	POST OFFICE ADDRESS		
	FULL NAME OF SIXTH INVENTOR	INVENTOR'S SIGNATURE	DATE
	RESIDENCE	CITIZENSHIP	
	POST OFFICE ADDRESS		
	FULL NAME OF SEVENTH INVENTOR	INVENTOR'S SIGNATURE	DATE
	RESIDENCE	CITIZENSHIP	
	POST OFFICE ADDRESS		

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